SOUTH FLORIDA WATER MANAGEMENT DISTRICT
EVERGLADES CONSTRUCTION PROJECT

STORMWATER TREATMENT AREA NO. 3 & 4
PLAN FORMULATION

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6. TWO-DIMENSIONAL HYDRAULIC ANALYSES

6.1 INTRODUCTION

6.1.1 Goals

This section of the report documents the detailed hydraulic analyses performed for the Stormwater Treatment Area (STA) 3/4 project. Both the base design configuration and the alternative design configurations described in Section 3 of the PFD were evaluated using Two-Dimensional (2-D) hydraulic models. Based on these evaluations, several design modifications were identified, additional models were developed, and recommendations for the STA's final design configuration were identified.

The specific goals identified for the 2-D hydraulic analyses include:

- Evaluation of the number, location, performance, and design criteria to be used for inflow and outflow control structures
- Identification of each design configuration's 2-D hydraulic performance characteristics and evaluation of the need to construct interior berms or filling canals to improve the overall hydropattern, minimize short-circuiting, and/or prevent re-suspension of particulate matter
- Generation of data that will be used to establish stage/storage relationships for each treatment cell, for use in levee design and long-term simulations of the STA's performance

General hydraulic design criteria for the project were developed in the General Design Memorandum (Burns & McDonnell, 1996). From these criteria and work completed subsequent to the memorandum, the following criteria were selected for use in 9 (and evaluation of) the 2-D modeling:

Minimum depth of flow ....0.5 feet (ft)
Maximum depth......................................90 percent of area equal to or less than 4.5 ft deep
Maximum velocity in marsh areas............0.1 feet per second (fps)
Maximum velocity in canals.....................2.5 fps
Manning's *n*...variable by location and depth of flow
Average Annual Inflow rate ....885 cubic feet per second (cfs)
Maximum Design Inflow rate...................5,840 cfs

6.1.2 Scope of Work

The scope of work for the detailed hydraulic analyses included development of 2-D hydraulic models for STA 3/4 and Water Conservation Area (WCA)-3A. These models were used to simulate the hydraulic characteristics of the STA and the WCA downstream of the proposed facilities. The 2-D elemental model Finite Element Surface Water Modeling System (FESWMS) and the data processing utility Surface Water Modeling System (SMS) were used for this project. Separate models were developed for WCA-3A and each STA cell.

The initial task for each model was the design of a finite element grid network. The objective of this activity was to accurately simulate the boundaries, internal features, and 2-D flow patterns within the STA and WCA-3A. The grid networks were based on Digital Terrain Models (DTM) developed during Subtask 3.2.6. In some cases, the aerial photography developed under Task 3.3 was used to confirm the design. Finite elements were constructed in varying sizes and shapes. A detailed grid network was constructed in areas expected to have the greatest importance, while larger elements were used to simulate areas of lesser concern or areas where fluctuations in the model's dependent variables were expected to be small. The level of detail used in the grid network designs was similar to that developed for 2-D hydraulic studies of STAs 5 and 6, with the exception of areas needed to simulate transverse ditches. Because the four major transverse ditches within STA 3/4 are to be left in place, the network designs in these areas included a higher level of detail than had been included in previous efforts.

Many hydraulic models were developed and evaluated during the course of this task. One model was developed for WCA-3A downstream of the STA site. Separate models were developed for each of the three cells described in the STA base design configuration (Cell 1, Cell 2, and Cell 3). Four models were developed for the STA alternative design configuration (Cell 1A, Cell 1B, Cell 2A, and Cell 2B). Finally, a hybrid of the finite element grid networks developed for each of these configurations was used to construct the five models that simulate the recommended STA design alternative (Cell 1A, Cell 1B, Cell 2A, Cell 2B, and Cell 3). Color graphics and tabular result files from each simulation were studied to determine compliance with the project's design criteria and overall performance goals. No statistical analyses were performed to verify compliance. Visual observations were based on color graphics showing topography, water surface elevations, water depths, velocities, and unit flow (depth x velocity). In general, observations made from results of the initial model simulations were used to refine the designs and/or operating conditions for subsequent analyses. In some cases, several iterations of design configurations or operating conditions were evaluated before satisfactory results were achieved.

Each model was used to simulate one low-flow and one high-flow condition before being used to evaluate design changes or other operating criteria. The low-flow rate used for these simulations was the Average Annual Inflow rate. The high-flow rate used for these simulations was the Maximum Design Inflow rate. In general, the rates used were adapted from Section 3 of the PFD. Once the recommended design configuration was identified, two additional flow conditions were simulated to support data needs for rating curve development and the long-term simulations.

6.1.3 Contents

The remaining discussion on 2-D hydraulic analyses is organized in the following parts:

- 6.2 STA 3/4 Models
- 6.3 WCA-3A Model
- 6.4 Summary

Section 6.2 describes the general data sources, model input data, and the results for the STA 3/4 models. It includes descriptions of the specific footprints, grid designs, and boundary conditions specified for each simulation. This section also includes commentary on model results and a summary of the design modifications made to improve the performance of each alternative. Section 6.3 contains similar information on the model developed for WCA-3A. Section 6.4 summarizes observations for the recommended design configuration and discusses sources of error and model limitations.

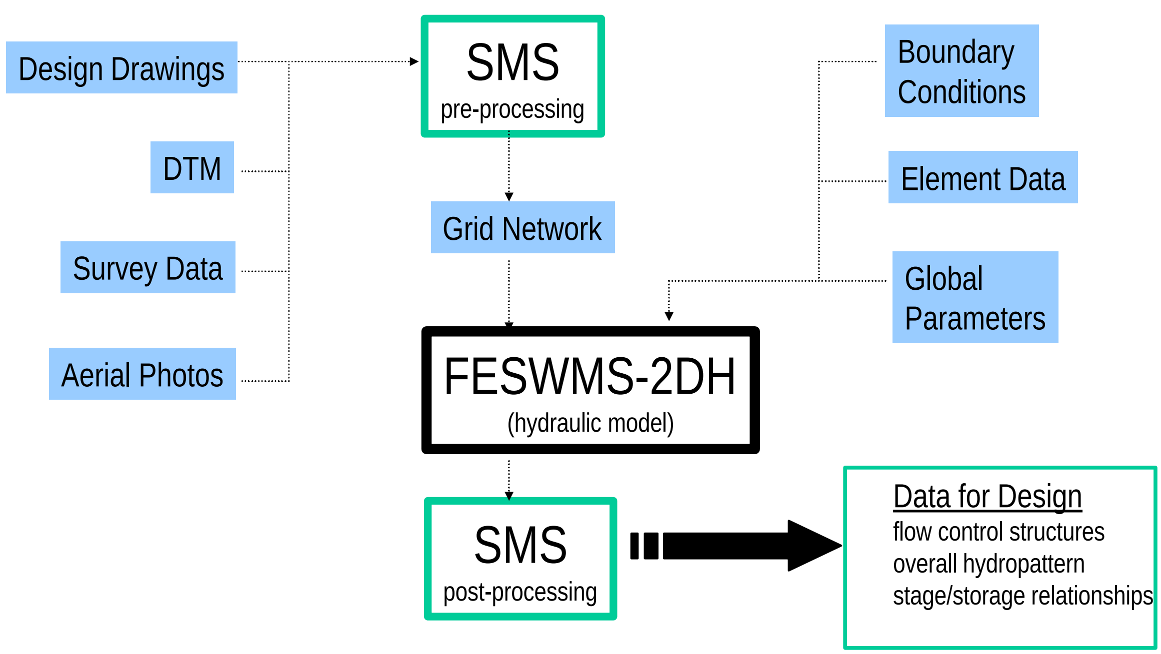
6.2 STA MODELS

6.2.1 General

This section of the report describes the general data sources and assumptions used to develop the 2-D hydraulic models for the STA cells. Data sets described below include the STA footprints, DTMs, surveys, aerial photographs, and design reports or specifications. These data sets were used to define the spatial bounds and topography for each model. This section of the report also describes the global hydraulic parameter values used by FESWMS and discussed at the Modeling Charrette held at the District's offices on March 2, 1999.

Figure 6.1 is a diagram showing the relationships of basic data sources and the modeling tools.

Figure 6.1 Relationship of Basic Data Sources and Modeling Tools



6.2.2 Model Input Data

The basic footprint used for the STA models is defined in the Phase 1 Configuration Task Report completed for Subtask 2.9. This report describes the external footprint of the STA as the general design boundary with the "toe of the boot" removed and the northern boundary shifted approximately 5/6 of a mile north of the original general design boundary. Figure 6.2 shows the general footprint for the STA model.

The DTM created during Subtask 3.2.6 defines the topographic characteristics of the interior of the STA. This DTM was created using GPS technology and was supplemented with conventional surveys to define the prevailing land surface elevations and gradients. The datum for this DTM and all other model databases is National Geodetic Vertical Datum (NGVD), 1929. A large number of cross-sections, including some along interval ditches and berms, were surveyed within the STA boundaries. North-south ditches and berms were later removed from the DTM since ditches will be filled and berms will be degraded during construction. Four major east-west ditches were incorporated into the DTM by the modeling team based on guidance from Burns & McDonnell (B&M). Based on discussions with the Design Team, several of these ditches were later plugged or filled to improve the system's hydraulic characteristics. These modifications are described in Section 6.3. Figure 6.2 shows the STA's general footprint, DTM points, and the locations of the four major east-west ditches.

The preliminary layout drawings shown in Section 3 of the PDF were used to define the locations of interior features of the STA, including levees, distribution canals, ditches, collection canals, and flow control structures. These drawings were provided in *dxf* format using the same georeferencing as was used in the DTMs.

Black-and-white aerial photography was used to supplement other sources of data during model development. The aerial photography was compiled from flights on February 20, 1999, at an elevation of 7,200 feet. The bounds of the photographic images include the entire STA footprint and adjacent properties within a range of approximately 0.5 to 0.75 miles to the north, east, south, and west. The digital images were provided in *tif* format on three CDs. The pixel resolution for this data is approximately 1 foot. A world file (*twf* format) with georeferencing information was also provided for each of the digital photographs. The coordinate system used in these files is the same as that used in the DTM. These photographs were used to confirm the locations of major canals and existing features in the vicinity of the STA.

Figure 6.2 – General Footprint of WCA-3A Hydraulic Model [CADD Figure]

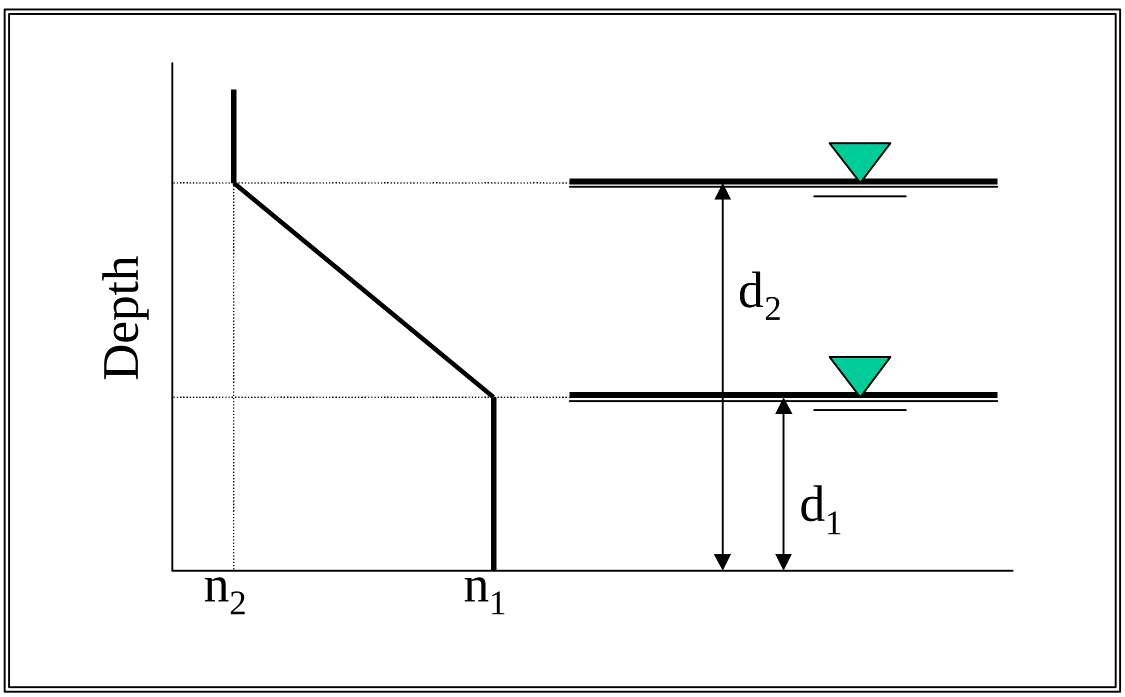
6.2.3 Global Hydraulic Parameters

The 2-D hydraulic characteristics of STA 3/4 were simulated using the FESWMS model. This model requires input of several global hydraulic parameters in addition to spatial and topographic data. The following paragraphs describe the user-specified parameters necessary to the FESWMS model and the specific values used for this project. A more detailed discussion of the program's operations and each of these parameters can be found in the FESWMS User's Manual.

6.2.3.1 Shear Stresses

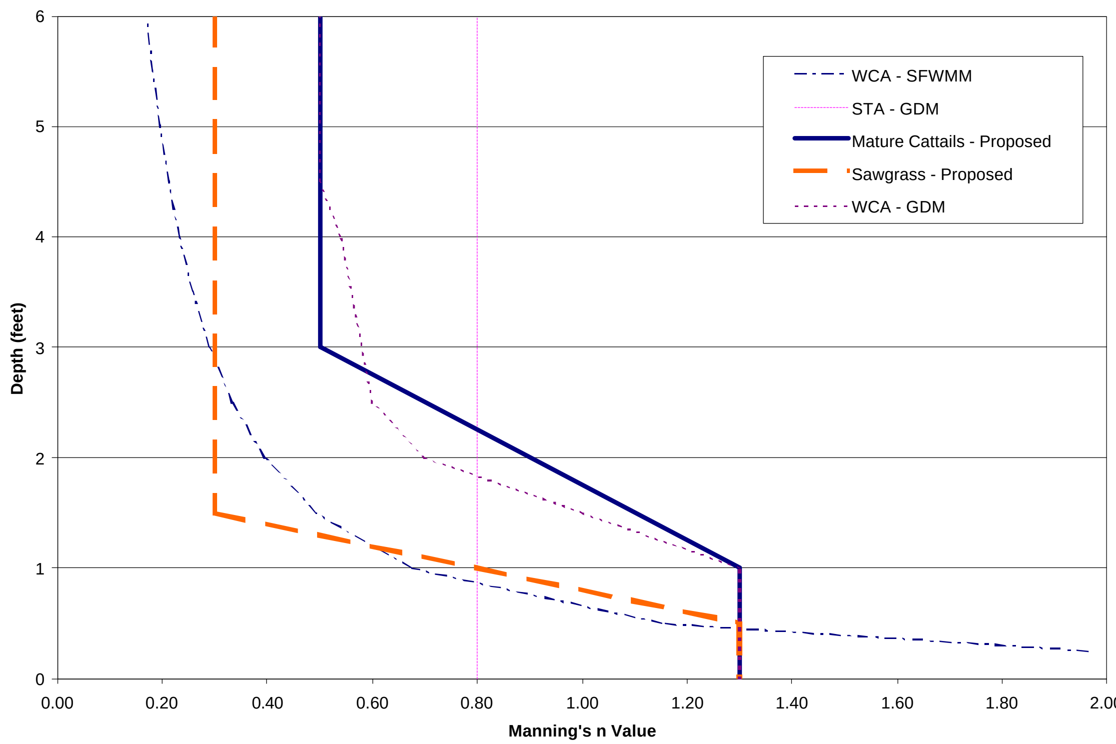
FESWMS supports the simulation of both bottom shear stresses and surface shear stresses. Bottom shear stresses, and the user-specified variables used to simulate them, typically have a significant impact on simulation results. Bottom shear stresses can be calculated using Manning's or Chezy relationships. Manning's *n* values were used for this project. Manning's *n* values must be specified for each element within the grid network. Either constant *n* values or a depth-variant relationship can be used. Figure 6.3 shows the relationship used in FESWMS to define depth-variable *n* values.

Figure 6.3 Relationship Used in FESWMS to Define Depth Variable Manning's *n* Values



Selection of appropriate values for Manning's *n* typically depends on the vegetation type, vegetation density, surface irregularities, soil types, and other hydraulic characteristics within each region of a model. Appropriate values for natural and created wetland systems are typically an order of magnitude larger than those used to simulate traditional open channel flow situations. Field-measured data have been used to calculate *n* values specific to several wetland systems. Figure 6.4 shows several relationships between Manning's *n* and flow depths for natural and constructed wetlands.

Figure 6.4 Manning's *n* Values for Natural and Constructed Wetlands



Although hydraulic calculations performed for STA 3/4 during the previous design phases were based on a constant *n* of 0.8 (B&M, April 1996), a depth-varying relationship was used during this phase of the project. Recent field studies at the Everglades Nutrient Removal (ENR) site indicate that a depth-dependent Manning's *n* relationship is more applicable for the STA than is the use of a constant *n* value. Depth-dependent Manning's *n* values of the ENR are representative of a mixture of vegetation (mature cattails) and open water. Table 6.1 shows the relationship between depth and Manning's *n* used for the STA.

Table 6.1
STA 3/4
Mature Cattails

Depth (ft)	Manning's *n*
> 6.0	0.5
3.0	0.5
3.0 to 1.0	Varies linearly
1.0	1.3
0	1.3

The Manning's *n* values for natural ditches and canals were consistent with those determined in the General Design Memorandum (GDM) for STA 3/4 and previous studies of canal hydraulics in south Florida, including:

- U.S. Army Corps of Engineers, Central and Southern Florida Project, Part VI General Studies and Reports, Section 5 Design Memorandum Channel Roughness, 1953.
- Burns & McDonnell, Supplemental Analysis of the L-3 Borrow Canal, Stormwater Treatment Area No. 5, 1999.

As shown in Table 6.2, the value used for maintained canals is applicable for straight and uniform earth channels, free of aquatic vegetation, and values for natural ditches are based on hydraulic radius.

Table 6.2
Natural Ditches and
Maintained Canals

Hydraulic Radius (ft)	Manning's *n*
12.0	0.030
8.5	0.032
6.5	0.036
4.0	0.044
Maintained Canals	0.028

Surface shear stresses associated with wind forces can also be simulated with FESWMS; however, the effects of wind forces are usually small. Therefore, wind forces typically are not included in FESWMS simulations. For this project, the surface stresses resulting from wind forces were not simulated in the FESWMS models.

6.2.3.2 Inertial Forces

FESWMS also allows user specification of several variables related to inertial forces. These variables address variations in vertical velocity profiles, temporal acceleration, and the Coriolis force.

Two momentum correction coefficients can be used to address variations in a water body's vertical velocity distribution. The program's default values for these correction coefficients assume that they are constant throughout the water body. If site-specific field data on vertical velocity distributions are provided, these data could be used to define momentum correction factors for the project of consideration. Because these variables do not generally have a significant impact on model results and because field data do not exist within the project area, the program's default values were used in all models.

FESWMS allows the user to specify the value of one variable related to temporal acceleration. Because only steady-state conditions were simulated, however, this variable will not be used for this project.

FESWMS can account for the effects of Coriolis forces, which are the impacts of the Earth's rotation on water movement. Although these effects are generally quite small[1] for most shallow flows, Coriolis forces can be simulated as a function of the mean latitude of the study area. For the STA model(s), a mean latitude of 26° 21' 15"N was used. For the WCA-3A model, a mean latitude of 26° 18' 37"N was used.

6.2.3.3 Stresses Caused by Turbulence

FESWMS uses the Boussinesq's eddy viscosity concept to calculate momentum changes resulting from turbulence. The concept assumes that the effects of turbulence are proportional to the depth-averaged velocity. Two user-specified variables are required: the base kinematic eddy viscosity and a dimensionless coefficient. The eddy viscosity can have a significant impact on model results. High values (1,000 to 2,000 square feet/second [ft^2/sec]) dampen variations in water surface elevations and are occasionally required to help complex

[1] To quantify the model's sensitivity to Coriolis forces, the Cell 1 model for the base design configuration was evaluated with and without Coriolis forces. The results from these simulations showed the variation in water surface elevation from west to east to be less than 0.01 feet at the maximum design inflow rate.

models reach interim solutions. Lower values (10 to 150 ft^2/sec) allow for greater variations in water surface elevations and are typically used for final simulations of natural systems.

Because field data specific to the hydraulic conditions anticipated in STA 3/4 were not available, a sensitivity analysis was performed to aid in selection of appropriate eddy viscosity values for this project. Several simulations were performed using a test configuration similar to that expected in the vicinity of flow control structures (where velocity gradients were expected to be the largest). The test compared the impacts of a broad range of grid sizes and eddy viscosities on water surface profiles. These tests demonstrated that the model's results are more sensitive to eddy viscosity than they were to element sizes. Based on the observations made during these tests, a value of 15 ft^2/sec was selected for this project.

No specific field data were available for the dimensionless coefficient used in the FESWMS model. The program’s author, however, suggests an approximate value of 0.6 for natural channels. This value was used in all modeling simulations.

6.2.4 Boundary Conditions

FESWMS requires that boundary conditions be specified around the entire boundary of each model. Two types of boundaries can be specified: closed boundaries and open boundaries. Closed boundaries define geometric features of the system such as levees and shorelines, where no flows are conveyed to or from the model. FESWMS allows the user to specify one of three conditions at closed boundaries: slip, no-slip, or semi-slip conditions. Because most of the boundaries for each model are formed by levees, semi-slip conditions were specified to account for frictional resistance.

Open boundaries are defined for all areas of the model where flow is allowed to enter or leave the grid network. For the STA 3/4 treatment cells, these boundaries are the inflow and outflow control structures. Methods of simulating these structures were discussed at the Modeling Charrette held at the District’s offices on March 2, 1999. Based on these discussions, both distributed and point boundary conditions were evaluated during the sensitivity analyses described previously. These analyses demonstrated that the flow control structures could be specified as point inflows and point discharges. Therefore, all inflow boundaries for the STA models were specified as total flow rates normal to the boundary at a point. All outflow boundaries were specified as constant water surface elevations at a point, with total outflow at a point also specified in a small number of simulations. The approach for simulating open boundaries in each model is further discussed below. The specific flow rates and water surface elevations used at the boundaries are summarized in Section 6.2.5.

One low-flow scenario and one high-flow scenario were simulated for each of the treatment cells. The low-flow condition simulated was the Average Annual Inflow as defined in Section 3 of the PFD. This scenario generally involved routing a total flow of 885 cfs through the total treatment area. The high-flow scenario simulated Maximum Design Inflow and involved routing a total of 5,840 cfs through the treatment cells. The number of treatment cells, the number and location of control structures, and the distribution of flow into each of the structures are described in Section 6.2.5.

Discharges from the treatment cells occur at flow control structures. The boundary conditions specified for these structures are the controlling water surface elevation at the upstream end of each structure and, occasionally, the total flow through the structure. In most cases, the outflow control structures discharge into canals. For the Cells in Parallel design configuration, a water surface elevation at the structure was assumed and varied based on simulation results until the design criteria were met. For cells operating in series, starting water surface elevations for the upstream cells were determined based on 2-D model results from downstream cells and an allowance for headlosses through internal flow control structures. Based on direction from the design team, an allowance of 6 inches was used to account for headlosses in the model runs for the Maximum Design Inflow rate. The headloss at the Average Annual Inflow rate was assumed to be negligible. Specific values used for each simulation are described in Section 6.2.5.

6.2.5 Model Results

2-D hydraulic models, as shown in Figure 6.5, were developed for three different STA design configurations:

Figure 6.5, add figure with all 3 layouts on one page

STA Base Design Configuration/STA Alternative Design Configuration/STA Recommended Design Configuration

- The base design configuration
- An alternative design configuration
- The recommended design configuration

The configurations address the original Cells in Parallel concept, a Cells in Series concept, and a hybrid of the two. This hybrid is recommended for detailed design. Simulations for the first two design concepts were performed for the Average Annual Inflow rate and the Maximum Design Inflow rate. Simulations for the recommended design configuration included these two scenarios and two additional flow rates required to generate rating curves for the long-term simulation described in Section 7 of the PFD.

The Cells in Parallel concept was evaluated first. Color graphics and tabular result files from each simulation were studied to determine compliance with the project's design criteria and overall performance goals. Visual observations were based on color graphics showing: topography, water surface elevations, water depths, velocities, and unit flow (depth x velocity). Results from these simulations were then reviewed and discussed with the project team over the course of several progress meetings. During these meetings, refinements to the designs and the operating conditions were identified for inclusion in subsequent analyses to help better meet the project’s design criteria and performance goals. Examples of the refinements identified during these meetings include the following:

- Relocation or addition of inflow control structures
- Filling or plugging existing transverse ditches within the treatment cells
- Enlargement or other increases in the conveyance capacities of the collections canals
- Raising water surface elevations

These refinements were incorporated into the Cells in Series models, and similar meetings were held to discuss the results from these simulations. Refinements identified during these discussions were used to develop models for the recommended design configurations. The specific refinements identified for each model are discussed in the following paragraphs.

Water surface elevations used as boundary conditions for the Average Annual Inflow rate were developed from data provided in Section 3 of the PFD and 1-dimensional analyses of the discharge canals will be documented in Section 8 of the PFD. Water surface elevations for the Maximum Design Inflow rate were determined using an iterative approach. This approach identified the highest water surface elevation that could be used while still meeting the depth criteria specified for the treatment cells (water depth for 90 percent of the area at or less than 4.5 feet). The approach involved varying the downstream water surface elevation and running the models for each cell until visual observation showed that the criteria were met.

Separate models were developed for each of the three cells described in the STA base design configuration (Cell 1, Cell 2, and Cell 3). Four models were developed for the STA alternative design configuration (Cell 1A, Cell 1B, Cell 2A, and Cell 2B). A hybrid of the finite element grids developed for each of these configurations was used to construct the five models simulating the recommended design alternative (Cell 1A, Cell 1B, Cell 2A, Cell 2B, and Cell 3). In some cases, several iterations of design configurations or operating conditions were evaluated before satisfactory results were achieved.

The following paragraphs summarize the basic data used for each model, the model results, and the discussions of design modifications.

6.2.5.1 Base Design Configuration

The original modeling effort evaluated the flow distribution through three cells making up STA 3/4. These cells—Cell 1, Cell 2, and Cell 3, as shown in Figure 6.5—were modeled independently of one another for the flow rates discussed previously. The following paragraphs outline the assumptions and model control parameters used for each simulation. Graphical representation of the results is provided in Appendices F1 through F3.

Base Design Configuration - Cell 1

Cell 1 is the largest of the three cells and receives all of the incoming flow from the North New River Canal. The inflow and outflow structures were simulated by point inflows and outflows, respectively. Table 6.3 summarizes general model information, and Table 6.4 outlines the model parameters used for the Maximum Design Inflow and the Average Annual Inflow models.

Table 6.3
Base Design Configuration Cell 1 Model Information

Description	Value
Treatment area (acres)	6,476
Number of inflow structures	6
Number of outflow structures	6
Approximate average ground elevation (ft)	9.3
Minimum ground elevation (ft)	-1.50 (at interior ditch invert)
Maximum ground elevation (ft)	10.38
Number of nodes	15,497
Number of elements	5,204

Table 6.4
Base Design Configuration Cell 1 Model Parameters

Description	Maximum Design Inflow	Average Annual Inflow
Inflow (cfs)	2,170	398
Average upstream water surface elevation (ft)	13.99	11.86
Downstream water surface elevation (ft)	12.8	10.6
Date of model run	October 22, 1999	October 22, 1999

A review of the model results for the Maximum Design Inflow condition indicated a reasonably uniform flow distribution across the cell. Uniformity is a qualitative goal based on visual examination of water depth and flow color graphics. The maximum and minimum water depths within the cell marsh area were 5.0 ft and 3.03 ft, respectively. The unit flow within the marsh area varied from approximately 0.0 cfs to 0.32 cfs. Velocity within the marsh area was between 0.0 fps and 0.073 fps; maximum velocities at the inflow and outflow structures were approximately 0.693 fps and 0.52 fps, respectively.

A review of the model results for the Average Annual Inflow condition also indicated a reasonably uniform flow distribution across the cell. The maximum and minimum water depths within the cell marsh area were 2.84 ft and 0.74 ft, respectively. The unit flow within the marsh area varied from approximately 0.0 cfs to 0.08 cfs. Velocity within the marsh area was between 0.0 fps and 0.04 fps; maximum velocities at the inflow and outflow structures were approximately 0.15 fps and 0.12 fps, respectively.

These model results were presented and discussed at a progress meeting on October 27, 1999. Because of the relatively uniform flow distribution observed from this model simulation, no modifications to the model design were suggested.

Base Design Configuration - Cell 2

Cell 2 receives an area-weighted portion of the incoming flow from the Miami Canal. The inflow and outflow structures were simulated by point inflows and outflows, respectively. Table 6.5 summarizes general model information, and Table 6.6 outlines the model parameters used for the Maximum Design Inflow and the Average Annual Inflow models.

Table 6.5
Base Design Configuration Cell 2 Model Information

Description	Value
Treatment area (acres)	5,330
Number of inflow structures	5
Number of outflow structures	5
Approximate average ground elevation (ft)	9.65
Minimum ground elevation (ft)	-1.50 (at interior ditch invert)
Maximum ground elevation (ft)	10.92
Number of nodes	16,885
Number of elements	5,662

Table 6.6
Base Design Configuration Cell 2 Model Parameters

Description	Maximum Design Inflow	Average Annual Inflow
Inflow (cfs)	1,980	263
Average upstream water surface elevation (ft)	14.14	11.78
Downstream water surface elevation (ft)	13.1	10.9
Date of model run	October 23, 1999	October 23, 1999

A review of the model results for the Maximum Design Inflow condition indicated a reasonable flow distribution across the cell. The maximum and minimum water depths within the cell marsh area were 4.85 ft and 2.35 ft, respectively. The unit flow within the marsh area varied from approximately 0.0 cfs to 0.39 cfs. Velocity within the marsh area was between 0.0 fps and 0.92 fps; maximum velocities at the inflow and outflow structures were approximately 0.92 fps and 0.67 fps, respectively.

A review of the model results for the Average Annual Inflow condition also indicated a reasonable flow distribution across the cell. The maximum and minimum water depths within the cell marsh area were 2.83 ft and 0.003 ft, respectively. The unit flow within the marsh area varied from approximately 0.0 cfs to 0.055 cfs. Velocity within the marsh area was between 0.0 fps and 0.19 fps; maximum velocities at the inflow and outflow structures were approximately 0.15 fps and 0.15 fps, respectively.

Two “dead zones” were predicted in the southern corners of the model for both the Maximum Design Inflow and Average Annual Inflow conditions. Model results for the Average Annual Inflow condition also indicated several areas of low water depths and an imbalance of flow with higher unit flows predicted in the eastern half of the treatment cell. Model results were presented and discussed at a progress meeting on October 27, 1999.

To address the imbalance of flow observed in the results, various model modifications were suggested should this configuration be chosen for design. These modifications included adjustment of the inflow and outflow control structure locations, the addition of “plugs” to the internal ditches, and the addition of a north-south berm in the southern portion of the model.

Base Design Configuration - Cell 3

Cell 3 is the smallest of the three cells and also receives an area-weighted portion of the incoming flow from the Miami Canal. The inflow and outflow structures were simulated by point inflows and outflows, respectively. Table 6.7 summarizes general model information, and Table 6.8 outlines the model parameters used for the Maximum Design Inflow and the Average Annual Inflow models.

Table 6.7
Base Design Configuration Cell 3 Model Information

Description	Value
Treatment area (acres)	4,588
Number of inflow structures	5
Number of outflow structures	1
Approximate average ground elevation (ft)	9.6
Minimum ground elevation (ft)	-2.0 (at collection canal invert)
Maximum ground elevation (ft)	10.82
Number of nodes	30,778
Number of elements	10,639

Table 6.8
Base Design Configuration Cell 3 Model Parameters

Description	Maximum Design Inflow	Average Annual Inflow
Inflow (cfs)	1,690	224
Upstream water surface elevation (ft)	13.9	11.5
Downstream water surface elevation (ft)	12.9	11.0
Date of model run	November 8, 1999	November 7, 1999

Before the grid network for Cell 3 was designed, several modifications to the original cell design were suggested for inclusion in the model. These modifications included using a collection canal divided into six reaches, with each reach designed to successively accept one-sixth of the total flow; skewing the inflow control structures to the west; and adding “plugs” to internal ditches 1, 2, and 3 at one-third length intervals. These modifications were incorporated into the grid network and model design.

A review of the model results for the Maximum Design Inflow condition indicated a poor flow distribution across the cell. The maximum and minimum water depths within the cell marsh area were 4.9 ft and 2.66 ft, respectively. The unit flow within the marsh area varied from approximately 0.0 cfs to 0.56 cfs. Velocity within the marsh area was between 0.0 fps and 0.22 fps; maximum velocities at the inflow and outflow structures were approximately 0.91 fps and 2.2 fps, respectively.

A review of the model results for the Average Annual Inflow condition also indicated a poor flow distribution across the cell. The maximum and minimum water depths within the cell marsh area were 2.44 ft and 0.27 ft, respectively. The unit flow within the marsh area varied from approximately 0.0 cfs to 0.04 cfs. Velocity within the marsh area was between 0.0 fps and 0.025 fps; maximum velocities at the inflow and outflow structures were approximately 0.15 fps and 0.32 fps, respectively.

Results for the Cell 3 model were presented and discussed in a conference call on November 11, 1999. These results show a reasonably uniform water depth for the Maximum Design Inflow condition. Undesirable water depths were observed across the area under the average annual flow condition, and a significant flow “dead zone” was observed in the southwest corner of the model. This dead zone was markedly more pronounced under the

Maximum Design Inflow condition than the Average Annual Inflow condition. Velocity distributions followed the same pattern as unit flow.

Because of the poor flow distribution, several additional modifications to the Cell 3 model were suggested. These modifications were carried forward into the Cells in Series, Cell 2A modeling as well as all subsequent modeling of the area. The modifications included reconfiguration of the collection canal with only two design cross sections (the smaller cross section spanning the western half length of the canal and the larger cross section covering the eastern half length); filling the eastern 1.5 miles of internal ditch 3 to existing grade and removing the western plug; and raising the downstream starting water surface elevation to mitigate the “dead zone” observed in the southwest corner of the model.

6.2.5.2 Alternative Design Configuration

The second modeling effort evaluated the flow distribution through four cells making up STA 3/4. These cells—Cell 1A, Cell 1B, Cell 2A, and Cell 2B as shown in Figure 6.5—were modeled independently of one another for the flow rates discussed previously. An iterative approach was used to balance the flow between the cells and meet the depth criteria discussed previously for the Maximum Design Inflow. The following paragraphs outline the assumptions and model control parameters used for each simulation. Graphical representations of the results are provided in Appendices F4 through F7.

Alternative Design Configuration - Cell 1A

Cell 1A is approximately the northern two-thirds portion of Cell 1 from the Cells in Parallel design basis. As in the Cells in Parallel models, the inflow and outflow structures were simulated by point inflows and outflows, respectively. Table 6.9 summarizes general model information, and Table 6.10 outlines the model parameters used for the Maximum Design Inflow and the Average Annual Inflow models.

Table 6.9
Alternative Design Configuration Cell 1A Model Information

Description	Value
Treatment area (acres)	3,408
Number of inflow structures	6
Number of outflow structures	6
Approximate average ground elevation (ft)	9.35
Minimum ground elevation (ft)	-1.50 (at interior ditch invert)
Maximum ground elevation (ft)	10.38
Number of nodes	13,760
Number of elements	4,605

Table 6.10
Alternative Design Configuration Cell 1A Model Parameters

Description	Maximum Design Inflow	Average Annual Inflow
Inflow (cfs)	2,170	398
Upstream water surface elevation (ft)	14.0	11.7
Downstream water surface elevation (ft)	13.4	10.6
Date of model run	November 3, 1999	November 11, 1999

A review of the model results for the Maximum Design Inflow condition indicated a reasonably uniform flow distribution across the cell. The maximum and minimum water depths within the cell marsh area were 4.95 ft and 3.2 ft, respectively. The unit flow within the marsh area varied from approximately 0.0 cfs to 0.34 cfs. Velocity within the marsh area was between 0.0 fps and 0.07 fps; maximum velocities at the inflow and outflow structures were approximately 0.69 fps and 0.63 fps, respectively.

A review of the model results for the Average Annual Inflow condition also indicated a reasonably uniform flow distribution across the cell. The maximum and minimum water depths within the cell marsh area were 2.86 ft and 0.67 ft, respectively. The unit flow within the marsh area varied from approximately 0.0 cfs to 0.081 cfs. Velocity within the marsh area was between 0.0 fps and 0.031 fps; maximum velocities at the inflow and outflow structures were approximately 0.16 fps and 0.17 fps, respectively.

These model results were presented and discussed at a progress meeting on December 1, 1999. Because of the relatively uniform flow distribution observed from this model simulation, no modifications to the grid network were suggested. The only suggested modifications to the model were to raise the downstream starting water surface elevation for

Cell 1A from its present level to 0.5 feet above the upstream water surface elevation predicted by the Cell 1B model for the Maximum Design Inflow condition (to account for internal structural headlosses), and to use the upstream water surface elevation predicted by the Cell 1B model as the downstream starting water surface elevation (with no headloss through internal structures) for Cell 1A under the Average Annual Inflow condition. Calculated headlosses through the internal structures were less than 0.1 ft under the Average Annual Inflow condition and were, therefore, assumed to be negligible.

Alternative Design Configuration - Cell 1B

Cell 1B is approximately the southern one-third portion of Cell 1 from the Cells in Parallel design basis. As in the Cells in Parallel models, the inflow and outflow structures were simulated by point inflows and outflows, respectively. Table 6.11 summarizes general model information, and Table 6.12 outlines the model parameters used for the Maximum Design Inflow and the Average Annual Inflow models.

Table 6.11
Alternative Design Configuration Cell 1B Model Information

Description	Value
Treatment area (acres)	2,941
Number of inflow structures	6
Number of outflow structures	6
Approximate average ground elevation (ft)	9.25
Minimum ground elevation (ft)	-0.5 (at collection canal invert)
Maximum ground elevation (ft)	9.88
Number of nodes	4,959
Number of elements	1,608
Assumed inflow structure headloss (ft)	0.2

Table 6.12
Alternative Design Configuration Cell 1B Model Parameters

Description	Maximum Design Inflow	Average Annual Inflow
Inflow (cfs)	2,170	398
Upstream water surface elevation (ft)	13.2	11.25
Downstream water surface elevation (ft)	12.9	10.6
Date of model run	November 3, 1999	November 11, 1999

A review of the model results for the Maximum Design Inflow condition indicated a reasonably uniform flow distribution across the cell. The maximum and minimum water depths within the cell marsh area were 4.46 ft and 3.16 ft, respectively. The unit flow within the marsh area varied from approximately 0.0 cfs to 0.26 cfs. Velocity within the marsh area was between 0.0 fps and 0.064 fps; maximum velocities at the inflow and outflow structures were approximately 0.46 fps and 0.51 fps, respectively.

A review of the model results for the Average Annual Inflow condition also indicated a reasonably uniform flow distribution across the cell. The maximum and minimum water depths within the cell marsh area are 2.46 ft and 0.78 ft, respectively. The unit flow within the marsh area varied from approximately 0.0 cfs to 0.06 cfs. Velocity within the marsh area was between 0.0 fps and 0.036 fps; maximum velocities at the inflow and outflow structures were approximately 0.13 fps and 0.13 fps, respectively.

These model results were presented and discussed at a progress meeting on December 1, 1999. Because of the relatively uniform flow distribution observed from this model simulation, no modifications to the model design were suggested.

Alternative Design Configuration - Cell 2A

Cell 2A is a combination of approximately the northern two-thirds of Cell 2 and all of Cell 3 from the Cells in Parallel design basis. As in the Cells in Parallel models, the inflow and outflow structures were simulated by point inflows and outflows, respectively. Table 6.13 summarizes general model information, and Table 6.14 outlines the model parameters used for the Maximum Design Inflow and the Average Annual Inflow models.

Table 6.13
Alternative Design Configuration Cell 2A Model Information

Description	Value
Treatment area (acres)	7,416
Number of inflow structures	10
Number of outflow structures	6 for design inflow/5 for average annual inflow
Approximate average ground elevation (ft)	9.7
Minimum ground elevation (ft)	-4.0 (at collection canal invert)
Maximum ground elevation (ft)	10.81
Number of nodes	22,826
Number of elements	7,797

Table 6.14
Alternative Design Configuration Cell 2A Model Parameters

Description	Maximum Design Inflow	Average Annual Inflow
Inflow (cfs)	3,670	487
Upstream water surface elevation (ft)	14.3	12.75
Downstream water surface elevation (ft)	14.0	11.0
Date of model run	December 5, 1999	December 5, 1999

A review of the model results for the Maximum Design Inflow condition indicated a reasonable flow distribution across the cell. The maximum and minimum water depths within the cell marsh area were 5.4 ft and 3.41 ft, respectively. The unit flow within the marsh area varied from approximately 0.0 cfs to 0.5 cfs. Velocity within the marsh area was between 0.0 fps and 0.15 fps; maximum velocities at the inflow and outflow structures were approximately 0.51 fps and 2.0 fps, respectively.

A review of the model results for the Average Annual Inflow condition also indicated a reasonable flow distribution across the cell. The maximum and minimum water depths within the cell marsh area were 3.16 ft and 1.26 ft, respectively. The unit flow within the marsh area varied from approximately 0.0 cfs to 0.12 cfs. Velocity within the marsh area was between 0.0 fps and 0.06 fps; velocities at the inflow and outflow structures were approximately 0.09 fps and 0.23 fps, respectively.

These model results were presented and discussed in a conference call on December 9, 1999. It was noted that water depths under the Maximum Design Inflow condition exceeded 4.5 feet over approximately 85 percent of the model area. This is because the upstream water surface elevations and internal structure headlosses from Cell 2B were used to estimate the downstream starting water surface elevation for the Cell 2A model. Unit flow and velocity profiles indicated the same dead zone in the southwest corner of the model as seen in the Cell 3 results. Much smaller dead zones were also observed in the two eastern corners of the model. Finally, under the Maximum Design Inflow condition, significant mounding for unit flow and velocity was observed at the discharge point representing discharge structure G-382.

In response to these model results, several modifications to the grid network design were suggested. The major modification was to split Cell 2A into two cells—Cells 2A and 3—along the levee length proposed between the original Cells 2 and 3. Additional modifications suggested (for the purpose of improving flow distribution and better utilization of the available treatment area) included adding a north-south canal running from the inflow canal along the western boundary of the new Cell 3 area to a point 1 mile north of the southern boundary of this area; positioning the inflow control structures such that three of the structures are within the western one-third of the area and the remaining two are in the eastern two-thirds; and raising the downstream starting water surface elevation to 13.6 feet (the design limitation of the discharge structure).

Alternative Design Configuration -Cell 2B

Cell 2B is approximately the southern one-third of Cell 2 from the Cell in Parallel design basis. As in the Cells in Parallel models, the inflow and outflow structures were simulated by point inflows and outflows, respectively. Table 6.15 summarizes general model information, and Table 6.16 outlines the model parameters used for the Maximum Design Inflow and the Average Annual Inflow models.

Table 6.15
Alternative Design Configuration Cell 2B Model Information

Description	Value
Treatment area (acres)	2,410
Number of inflow structures	5
Number of outflow structures	5
Approximate average ground elevation (ft)	9.7
Minimum ground elevation (ft)	-0.5 (at collection canal invert)
Maximum ground elevation (ft)	10.92
Number of nodes	4,650
Number of elements	1,513
Assumed inflow structure headloss (ft)	0.5

Table 6.16
Alternative Design Configuration Cell 2B Model Parameters

Description	Maximum Design Inflow	Average Annual Inflow
Inflow (cfs)	1,980	487
Upstream water surface elevation (ft)	13.5	11.8
Downstream water surface elevation (ft)	13.1	11.0
Date of model run	December 1, 1999	November 30, 1999

A review of the model results for the Maximum Design Inflow condition indicated a reasonable flow distribution across the cell. The maximum and minimum water depths within the cell marsh area were 4.42 ft and 2.32 ft, respectively. The unit flow within the marsh area varied from approximately 0.0 cfs to 0.20 cfs. Velocity within the marsh area was between 0.0 fps and 0.072 fps; maximum velocities at the inflow and outflow structures were approximately 0.59 fps and 0.80 fps, respectively.

A review of the model results for the Average Annual Inflow condition also indicated a reasonable flow distribution across the cell. The maximum and minimum water depths within the cell marsh area were 2.58 ft and 0.12 ft, respectively. The unit flow within the marsh area varied from approximately 0.0 cfs to 0.015 cfs. Velocity within the marsh area was between 0.0 fps and 0.058 fps; maximum velocities at the inflow and outflow structures were approximately 0.18 fps and 0.37 fps, respectively.

These model results were presented and discussed at a progress meeting on December 1, 1999. Because of the relatively uniform flow distribution observed from this model simulation, no modifications to the model design were suggested.

6.2.5.3 Recommended Design Configuration

The final modeling effort evaluated the flow distribution through five cells making up STA 3/4. These cells—Cell 1A, Cell 1B, Cell 2A, Cell 2B, and Cell 3 as shown in Figure 6.5—were modeled independently of one another for four flow rates. Table 6.17 outlines the flow rates and downstream starting water surface elevations used in the recommended design configuration for the various cells.

Table 6.17
Flow and Elevation Information for Recommended Design Configuration

Cell 1A		Cell 1B		Cell 2A		Cell 2B		Cell 3	
Q (cfs)	El. (ft)*	Q (cfs)	El. (ft)	Q (cfs)	El. (ft)**	Q (cfs)	El. (ft)	Q (cfs)	El. (ft)
2,170	HW+0.5	2,170	12.8	1,980	HW+0.5	1,980	13.1	1,690	13.75
1,580	HW+0.3	1,580	12.4	1,410	HW+0.3	1,410	12.7	1,200	13.0
990	HW+0.1	990	11.9	840	HW+0.1	840	12.1	710	12.2
398	HW+0.0	398	11.2	263	HW+0.0	487	11.2	224	11.0

*These values represent the headwater (HW), or upstream water surface elevation (El.), for the corresponding Cell 1B simulation plus the structure headloss allowance specified.
** These values represent the headwater, or upstream water surface elevation, for the corresponding Cell 2B simulation plus the structure headloss allowance specified.

The structure headloss values in Table 6.17 were developed from calculating headlosses through a 10-ft x 10-ft control structure for each of the specified flow rates.

The following paragraphs outline the assumptions and model control parameters used for each simulation.

Recommended Design Configuration - Cell 1A

Cell 1A is the same model grid network (Figure 6.6) used in the Cells in Series configuration. Table 6.18 summarizes general model information, and Table 6.19 outlines the model parameters used for the four flow condition simulations.

Table 6.18
Recommended Design Configuration Cell 1A Model Information

Description	Value
Treatment area (acres)	3,408
Number of inflow structures	6
Number of outflow structures	6
Approximate average ground elevation (ft)	9.35
Minimum ground elevation (ft)	-1.50 (at interior ditch invert)
Maximum ground elevation (ft)	10.38
Number of nodes	13,760
Number of elements	4,605

Figure 6.6 Cell 1A – Grid Network and Topography

Table 6.19
Recommended Design Configuration Cell 1A Model Parameters

Description	Maximum Design Inflow	Intermediate 1 Condition	Intermediate 2 Condition	Average Annual Inflow
Inflow (cfs)	2,170	1,580	990	398
Upstream water surface elevation (ft)	14.4	13.6	12.8	11.9
Downstream water surface elevation (ft)	13.8	13.1	12.35	11.5
Date of model run	December 15, 1999	December 15, 1999	December 15, 1999	December 15, 1999

A review of the model results (Figures 6.7 through 6.10) for the Maximum Design Inflow condition indicated a reasonably uniform flow distribution across the cell. The maximum and minimum water depths within the cell marsh area were 5.38 ft and 3.59 ft, respectively. However, more than approximately 70 percent of the area was covered by a water depth of 4.5 ft or greater. The unit flow within the marsh area varied from approximately 0.0 cfs to 0.34 cfs. Velocity within the marsh area was between 0.0 fps and 0.073 fps, and maximum canal velocity was approximately 0.67 fps.

A review of the model results (Figures 6.11 through 6.14) for the Average Annual Inflow condition also indicated a reasonably uniform flow distribution across the cell. The maximum and minimum water depths within the cell marsh area were 3.07 ft and 1.22 ft, respectively. The unit flow within the marsh area varied from approximately 0.0 cfs to 0.081 cfs. Velocity within the marsh area was between 0.0 fps and 0.028 fps, and maximum canal velocity was approximately 0.22 fps.

Recommended Design Configuration - Cell 1B

Cell 1B is the same model grid network (Figure 6.15) used in the Cells in Series configuration. Table 6.20 summarizes general model information, and Table 6.21 outlines the model parameters used for the four flow condition simulations.

Figure 6.7 Cell 1A Design Inflow – Water Surface Elevation

Figure 6.8 Cell 1A Design Inflow – Water Depth

Figure 6.9 Cell 1A Design Inflow – Unit Flow

Figure 6.10 Cell 1A Design Inflow - Velocity

Figure 6.11 Cell 1A Average Annual Inflow – Water Surface Elevation

Figure 6.12 Cell 1A Average Annual Inflow – Water Depth

Figure 6.13 Cell 1A Average Annual Inflow – Unit Flow

Figure 6.14 Cell 1A Average Annual Inflow - Velocity

Figure 6.15 Cell 1B – Grid Network and Topography

Table 6.20
Recommended Design Configuration Cell 1B Model Information

Description	Value
Treatment area (acres)	2,941
Number of inflow structures	6
Number of outflow structures	6
Approximate average ground elevation (ft)	9.25
Minimum ground elevation (ft)	-0.5 (at collection canal invert)
Maximum ground elevation (ft)	9.88
Number of nodes	4,959
Number of elements	1,608

Table 6.21
Recommended Design Configuration Cell 1B Model Parameters

Description	Maximum Design Inflow	Intermediate 1 Condition	Intermediate 2 Condition	Average Annual Inflow
Inflow (cfs)	2,170	1,580	990	398
Upstream water surface elevation (ft)	13.3	12.8	12.25	11.5
Downstream water surface elevation (ft)	12.8	12.4	11.9	11.2
Date of model run	December 15, 1999	December 15, 1999	December 15, 1999	December 15, 1999

A review of the model results (Figures 6.16 through 6.19) for the Maximum Design Inflow condition indicated a reasonably uniform flow distribution across the cell. The maximum and minimum water depths within the cell marsh area were 4.38 ft and 3.06 ft, respectively. The unit flow within the marsh area varied from approximately 0.0 cfs to 0.27 cfs. Velocity within the marsh area was between 0.0 fps and 0.11 fps, and maximum canal velocity was approximately 0.73 fps.

A review of the model results (Figures 6.20 through 6.23) for the Average Annual Inflow condition also indicated a reasonably uniform flow distribution across the cell. The maximum and minimum water depths within the cell marsh area were 2.63 ft and 1.37 ft, respectively. The unit flow within the marsh area varied from approximately 0.0 cfs to 0.057 cfs. Velocity within the marsh area was between 0.0 fps and 0.027 fps, and maximum canal velocity was approximately 0.22 fps.

Figure 6.16 Cell 1B Design Inflow – Water Surface Elevation

Figure 6.17 Cell 1B Design Inflow – Water Depth

Figure 6.18 Cell 1B Design Inflow – Unit Flow

Figure 6.19 Cell 1B Design Inflow - Velocity

Figure 6.20 Cell 1B Average Annual Inflow – Water Surface Elevation

Figure 6.21 Cell 1B Average Annual Inflow – Water Depth

Figure 6.22 Cell 1B Average Annual Inflow – Unit Flow

Figure 6.23 Cell 1B Average Annual Inflow - Velocity

Recommended Design Configuration - Cell 2A

Cell 2A now encompasses approximately the northern two-thirds of Cell 2 only, as shown in Figure 6.24. As in the Cells in Parallel models, the inflow and outflow structures were simulated by point inflows and outflows, respectively. Table 6.22 summarizes general model information, and Table 6.23 outlines the model parameters used for the four flow condition simulations.

Table 6.22
Recommended Design Configuration Cell 2A Model Information

Description	Value
Treatment area (acres)	2,867
Number of inflow structures	5
Number of outflow structures	5
Approximate average ground elevation (ft)	9.70
Minimum ground elevation (ft)	-1.5 (at internal ditch invert)
Maximum ground elevation (ft)	10.4
Number of nodes	13,962
Number of elements	4,683

Table 6.23
Recommended Design Configuration Cell 2A Model Parameters

Description	Maximum Design Inflow	Intermediate 1 Condition	Intermediate 2 Condition	Average Annual Inflow
Inflow (cfs)	1,980	1,410	840	263
Upstream water surface elevation (ft)	14.41	13.70	12.92	12.10
Downstream water surface elevation (ft)	13.8	13.2	12.56	11.9
Date of model run	December 20, 1999	December 23, 1999	December 23, 1999	December 18, 1999

A review of the model results (Figures 6.25 through 6.28) for the design flow condition indicated a reasonably uniform flow distribution across the cell. The maximum and minimum water depths within the cell marsh area were 5.40 ft and 3.53 ft, respectively, and approximately 60 percent of the area had a water depth of 4.5 ft or greater. The unit flow within the marsh area varied from approximately 0.0 cfs to 0.35 cfs. Velocity within the marsh area was between 0.0 fps and 0.079 fps, and maximum canal velocity was approximately 0.91 fps.

Figure 6.24 Cell 2A – Grid Network and Topography

Figure 6.25 Cell 2A Design Inflow – Water Surface Elevation

Figure 6.26 Cell 2A Design Inflow – Water Depth

Figure 6.27 Cell 2A Design Inflow – Unit Flow

Figure 6.28 Cell 2A Design Inflow - Velocity

For the Average Annual Inflow condition, an additional point inflow was added to the model at the western end of the collector canal. This inflow represents transfer of all outflow from Cell 3 to Cell 2A under Average Annual Inflow conditions. A review of the model results (Figures 6.29 through 6.32) for this flow condition also indicated varied flow distribution across the cell due to the additional flow introduced from Cell 3. The maximum and minimum water depths within the cell marsh area were 3.16 ft and 1.54 ft, respectively, with the southwest corner of the model exhibiting shallower water depths. The unit flow within the marsh area varied from approximately 0.0 cfs to 0.022 cfs. Velocity within the marsh area was between 0.0 fps and 0.095 fps, and maximum canal velocity was approximately 6.18 fps. This maximum canal velocity occurs immediately downstream of the discharge structure; canal velocity criteria are not otherwise violated.

Recommended Design Configuration - Cell 2B

Cell 2B, shown in Figure 6.33, is the same model grid network used in the Cells in Series configuration. Table 6.24 summarizes general model information, and Table 6.25 outlines the model parameters used for the four flow condition simulations.

Table 6.24
Recommended Design Configuration Cell 2B Model Information

Description	Value
Treatment area (acres)	2,410
Number of inflow structures	5
Number of outflow structures	5
Approximate average ground elevation (ft)	9.7
Minimum ground elevation (ft)	-0.5 (at collection canal invert)
Maximum ground elevation (ft)	10.92
Number of nodes	4,650
Number of elements	1,513

Table 6.25
Recommended Design Configuration Cell 2B Model Parameters

Description	Maximum Design Inflow	Intermediate 1 Condition	Intermediate 2 Condition	Average Annual Inflow
Inflow (cfs)	1,980	1,410	840	487
Upstream water surface elevation (ft)	13.5	13.0	12.46	11.9
Downstream water surface elevation (ft)	12.9	12.5	12.0	11.2
Date of model run	December 20, 1999	December 22, 1999	December 23, 1999	December 21, 1999

Figure 6.29 Cell 2A Average Annual Inflow – Water Surface Elevation

Figure 6.30 Cell 2A Average Annual Inflow – Water Depth

Figure 6.31 Cell 2A Average Annual Inflow – Unit Flow

Figure 6.32 Cell 2A Average Annual Inflow - Velocity

Figure 6.33 Cell 2B – Grid Network and Topography

A review of the model results (Figure 6.34 through 6.37) for the Maximum Design Inflow condition indicated a reasonable flow distribution across the cell. The maximum and minimum water depths within the cell marsh area are 4.46 ft and 2.14 ft, respectively. The unit flow within the marsh area varied from approximately 0.0 cfs to 0.39 cfs. Velocity within the marsh area was between 0.0 fps and 0.11 fps, and maximum canal velocity was approximately 0.84 fps.

A review of the model results (Figures 6.38 through 6.41) for the Average Annual Inflow condition indicated a skew of flow to the east within the cell. The maximum and minimum water depths within the cell marsh area were 2.61 ft and 0.22 ft, respectively. Approximately 13 percent of the model area was covered by less than 0.5 ft of water. The unit flow within the marsh area varied from approximately 0.0 cfs to 0.11 cfs. Velocity within the marsh area was between 0.0 fps and 0.053 fps, and maximum canal velocity was approximately 0.45 fps.

Recommended Design Configuration – Interim Cell 3

Cell 3 is the same model area used in the Cells in Parallel design basis; significant model changes have been made, however, as shown in Figure 6.42. In addition to the modifications incorporated into the Cells in Series modeling (reconfiguring the collector canal, shifting the inflow control structure location, adding a north-south canal, plugging internal ditches 1 and 2, and filling the eastern half of internal ditch 3), a north-south levee and an additional inflow control structure were added to the model to distribute flow more evenly.

The levee is 8,220 feet (1.56 miles) from the western boundary of Cell 3. The levee fully blocks the inflow canal and all internal ditches and essentially divides Cell 3 into two sub-cells. The additional inflow control structure was added within the eastern two-thirds of the area for a total of three inflow structures in this area.

As in the Cells in Parallel models, all inflow and outflow structures were simulated by point inflows and outflows, respectively. Table 6.26 summarizes general model information, and Table 6.27 outlines the model parameters used for the four flow condition simulations.

Figure 6.34 Cell 2B Design Inflow-Water Surface Elevation

Figure 6.35 Cell 2B Design Inflow – Water Depth

Figure 6.36 Cell 2B Design Inflow – Unit Flow

Figure 6.37 Cell 2B Design Inflow - Velocity

Figure 6.38 Cell 2B Average Annual Inflow – Water Surface Elevation

Figure 6.39 Cell 2B Average Annual Inflow – Water Depth

Figure 6.40 Cell 2B Average Annual Inflow – Unit Flow

Figure 6.41 Cell 2B Average Annual Inflow - Velocity

Figure 6.42 Cell 3 – Grid Network and Topography

Table 6.26
Recommended Design Configuration Interim Cell 3 Model Information

Description	Value
Treatment area (acres)	4,588
Number of inflow structures	6
Number of outflow structures	1
Approximate average ground elevation (ft)	9.6
Minimum ground elevation (ft)	-2.0 (at collection canal invert)
Maximum ground elevation (ft)	10.82
Number of nodes	30,778
Number of elements	10,639

Table 6.27
Recommended Design Configuration Interim Cell 3 Model Parameters

Description	Maximum Design Inflow	Intermediate Condition 1	Intermediate Condition 2	Average Annual Inflow
Inflow (cfs)	1,690	1,200	710	224
Upstream water surface elevation (ft)	14.52 (west end)/ 14.22 (east end)	13.9 (west)/ 13.69 (east)	13.28 (west)/ 13.16 (east)	12.62 (west)/ 12.59 (east)
Downstream water surface elevation (ft)	13.5	13.2	12.9	12.5
Date of model run	December 20, 1999	December 21, 1999	December 21, 1999	December 27, 1999

A review of the model results (Figures 6.43 through 6.46) for the Maximum Design Inflow condition indicated a reasonably uniform flow distribution across the northern portions of the sub-cells with dead zones observed toward the southwest corners of the sub-cells. The maximum and minimum water depths within the cell marsh areas were 5.41 ft and 3.14 ft, respectively, with water depths an average of 3 inches greater to the west of the internal levee and approximately 55 percent of the area covered by 4.5 ft or more of water. The unit flow within the marsh areas varied from approximately 0.0 cfs to 0.7 cfs, with a lower average unit flow observed west of the levee. Velocity within the marsh areas was between 0.0 fps and 0.19 fps, and maximum canal velocity was approximately 2.58 fps. As with unit flows, a lower average velocity was observed west of the levee.

Figure 6.43 Cell 3 Design Inflow – Water Surface Elevation

Figure 6.44 Cell 3 Design Inflow – Water Depth

Figure 6.45 Cell 3 Design Inflow – Unit Flow

Figure 6.46 Cell 3 Design Inflow - Velocity

A review of the model results (Figure 6.47 through 6.50) for the Average Annual Inflow condition also indicated a reasonably uniform flow distribution across the northern portions of the sub-cells with dead zones observed toward the southwest corners of the sub-cells. The maximum and minimum water depths within the cell marsh area were 3.69 ft and 1.76 ft, respectively. The unit flow within the marsh area varied from approximately 0.0 cfs to 0.084 cfs. Velocity within the marsh area was between 0.0 fps and 0.036 fps, and maximum canal velocity was approximately 1.64 fps. Similar unit flows and velocities were observed in the marsh areas east and west of the levee.

Recommended Design Configuration – Final Cell 3

Because water depths and velocity magnitudes within both the marsh areas and in the canals exceeded the design criteria under Maximum Design Inflow conditions and the flow dead zone limits the effective treatment area across both sub-cells, the interim Cell 3 model was modified in an attempt to meet design conditions and most effectively use the available treatment area. The north-south canal in the northwest corner of the model and the north-south levee were removed. Internal ditch 3 was restored to its original condition, with a plug one-third of the ditch length from the eastern border of the cell. Finally, the number of outflow structures was increased from one structure at the east end of the collector canal to six outflow structures spaced approximately evenly. As in the Cells in Parallel models, all inflow and outflow structures were simulated by point inflows and outflows, respectively. Table 6.28 summarizes general model information, and Table 6.29 outlines the model parameters used for the four flow condition simulations.

A review of the model results (Figures 6.51 through 6.54) for the Maximum Design Inflow condition indicated a reasonably uniform flow distribution across the cell. The maximum and minimum water depths within the cell marsh area were 4.55 ft and 3.25 ft, respectively, with less than 1 percent of the area covered by 4.5 ft or more of water. The unit flow within the marsh area varied from approximately 0.0 cfs to 0.58 cfs. Velocity within the marsh area was between 0.0 fps and 0.14 fps, and maximum canal velocity was approximately 0.45 fps.

Figure 6.47 Cell 3 Average Annual Inflow – Water Surface Elevation

Figure 6.48 Cell 3 Average Annual Inflow – Water Depth

Figure 6.49 Cell 3 Average Annual Inflow – Unit Flow

Figure 6.50 Cell 3 Average Annual Inflow – Velocity

Figure 6.51 Modified Cell 3 Max. Design Inflow – Water Surface Elevation

Figure 6.52 Modified Cell 3 Max. Design Inflow – Water Depth

Figure 6.53 Modified Cell 3 Max. Design Inflow – Unit Flow

Figure 6.54 Modified Cell 3 Max. Design Inflow –Velocity

Table 6.28
Recommended Design Configuration Final Cell 3 Model Information

Description	Value
Treatment area (acres)	4,588
Number of inflow structures	6
Number of outflow structures	6
Approximate average ground elevation (ft)	9.6
Minimum ground elevation (ft)	-2.0 (at collection canal invert)
Maximum ground elevation (ft)	10.82
Number of nodes	14,178
Number of elements	4,893

Table 6.29
Recommended Design Configuration Final Cell 3 Model Parameters

Description	Maximum Design Inflow	Intermediate Condition 1	Intermediate Condition 2	Average Annual Inflow
Inflow (cfs)	1,690	1,200	710	224
Upstream water surface elevation (ft)	13.98	13.21	12.44	11.37
Downstream water surface elevation (ft)	13.75	13.0	12.2	11.0
Date of model run	April 17, 2000	April 18, 2000	April 18, 2000	April 17, 2000

A review of the model results (Figure 6.55 through 6.58) for the Average Annual Inflow condition also indicated a reasonably uniform flow distribution across the cell. The maximum and minimum water depths within the cell marsh area were 1.96 ft and 0.48 ft, respectively with less than 1 percent of the area having a water depth of less than 0.5 feet. The unit flow within the marsh area varied from approximately 0.0 cfs to 0.07 cfs.

Figure 6.55 Modified Cell 3 Ave. Annual Inflow – Water Surface Elevation

Figure 6.56 Modified Cell 3 Ave. Annual Inflow – Water Depth

Figure 6.57 Modified Cell 3 Ave. Annual Inflow – Unit Flow

Figure 6.58 Modified Cell 3 Ave. Annual Inflow – Velocity

Velocity within the marsh area was between 0.0 fps and 0.05 fps, and maximum canal velocity was approximately 0.13 fps.

6.3 WCA-3A MODEL

6.3.1 Model Input Data

As part of an effort to restore the Everglades to its historical hydropattern and hydroperiod, the South Florida Water Management District's (District) Everglades Restoration Division is evaluating the benefits and impacts associated with discharge of all or part of the treated flows from the six STAs into various WCAs. STA 3/4 abuts the northeast section of WCA. Although discharge from ST 3/4 to WCA-3A is not part of the recommended design, it may be implemented in the future. To determine how sheet flow discharges may impact WCA-3A should this option be implemented, a 2-D model of WCA-3A was constructed to estimate the water surface elevations and flow patterns downstream of the STA models. The footprint of the modeled area extends from the Miami Canal east to the North New River Canal and from the L-5 Canal south approximately 3 miles to the extent of the DTM data. The upstream boundary of the model was designed to simulate sheet flow discharges from a spreader canal extending from existing culvert G-206 to U.S. 27 (a distance of approximately 7 miles). Although this is only a small portion of WCA-3A, it is anticipated that any adverse impacts from sheet flow discharge would be magnified in this area and dampened throughout the rest of WCA-3A.

A separate DTM created during Task 3.2.6 defines the topographic characteristics of WCA-3A. This DTM was created using GPS technology and supplemented with conventional surveys to define the prevailing land surface elevations and gradients. A total of four sections were surveyed downstream of the STA 3/4 site and within WCA-3A. Figure 6.59 shows the boundaries of this DTM and the area to be included in the 2-D model.

6.3.2 Global Hydraulic Parameters

Vegetation mapping completed as part of Subtask 3.2.5 was used to identify *n* values for different regions of the WCA-3A model. This mapping describes the predominant vegetation types within the surveyed area as shown in Figure 6.60. The survey was completed with a 0.25-mile x 0.25-mile grid. Two predominant vegetative communities were observed: cattails

Figure 6.59 General Footprint of WCA-3A Hydraulic Model

Figure 6.60 WCA-3A Vegetation Patterns

and sawgrass. For areas dominated by a mature growth of cattails, the Manning's relationship described for the STA model was used. For other areas where sawgrass is the predominant vegetation, an approximation of the Manning's *n* relationship used in the District's South Florida Water Management Model (SFWMM) was used. These relationships are shown in Table 6.30. This approximation is also shown in Figure 6.4, presented previously.

Table 6.30
WCA-3A

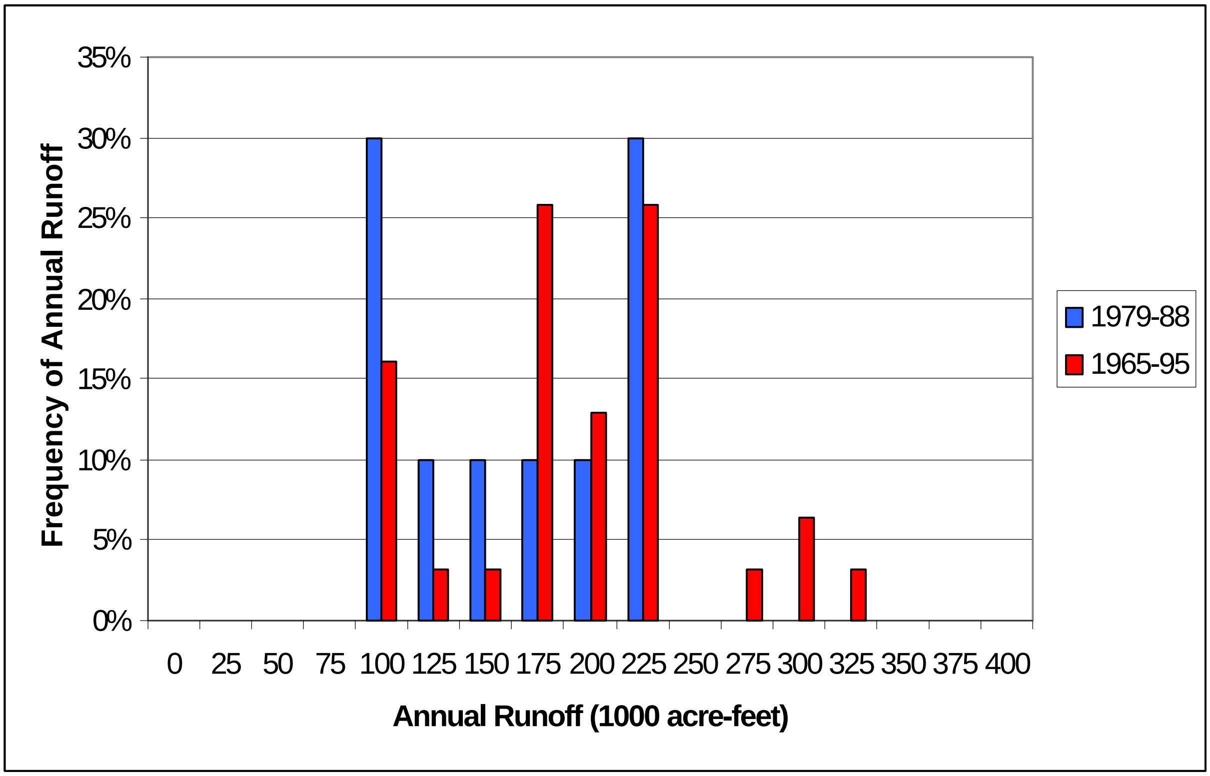
Depth (ft)	Manning's *n* (Sawgrass)	Manning's *n* (Mature Cattails)
> 6.0	0.3	0.5
3.0	0.3	0.5
3.0 to 1.0	--	Varies linearly
1.5	0.3	--
1.5 to 0.5	Varies linearly	--
1.0	--	1.3
0.5	1.3	--
0	1.3	1.3

6.3.3 WCA-3A Boundary Conditions

As discussed previously, the Everglades restoration seeks to restore hydropatterns within WCAs (including WCA-3A) to more closely match their historical natural sheet flow condition. In anticipation of and preparation to accomplish this objective, a number of flow control structures and/or a spreader canal could be included within the WCA. Because the design of these structures had not been determined before building the model of WCA-3A, this boundary was simulated as an open boundary with a deep zone upstream of WCA-3A. This approximation was intended to simulate ideal conditions and provide a target for the design of the proposed flow control structures. A fixed discharge of 1,500 cfs was simulated at this boundary pursuant to the Phase 1 Configuration Task Report completed for Subtask 2.9.

The downstream boundary for this portion of the WCA was modeled as a constant head boundary. A water surface elevation of 12.27 NGVD was selected for this boundary. This elevation exceeds the natural ground surface by 1 to 3 feet and was derived from an extrapolation of model results published in the GDM. The rating curve showing water surface elevations used for the GDM and the extrapolated value is shown in Figure 6.61.

Figure 6.61 HEC-2 Analysis of WCA-3A Performed for GDM



Source: General Design Memorandum STA 3/4, Burns & McDonnell, April 1996

Based on frequency analyses performed for gage data collected at station 3A-NE_B (approximately 3.5 miles south of the L-5 canal), this value was exceeded during less than 5 percent of the 27-year period of record. Figures 6.62 and 6.63 show data describing the historical stage levels at this gage.

6.3.4 WCA-3A Model

The WCA-3A model was developed to simulate the conditions immediately downstream of the STA 3/4 site. The inflow and outflow boundaries for this model were simulated as a distributed inflow and a constant water surface elevation, as described in Section 6.3.3. Table 6.31 summarizes general model information, and Table 6.32 outlines the model parameters used for the one flow scenario simulated for this area.

Figure 6.62 Historic Stage Levels at Gage 3A-NE_B for 27-Year Record

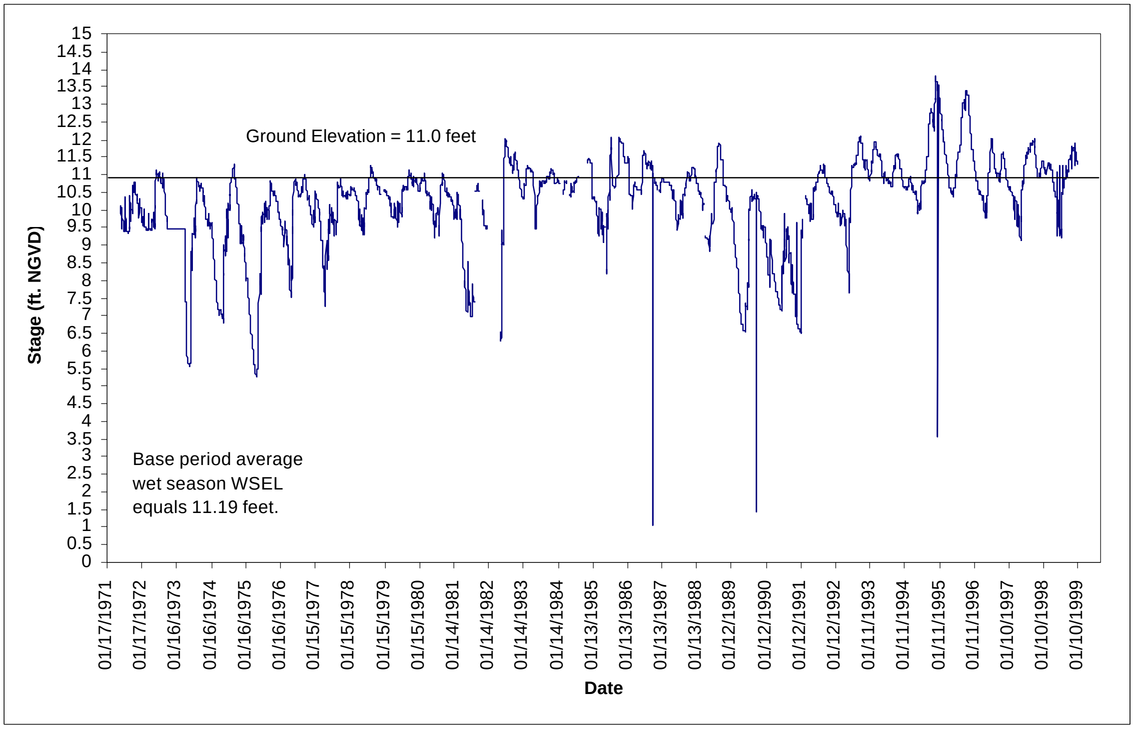


Figure 6.63 Exceedance Relationship for Gage 3A-NE_B

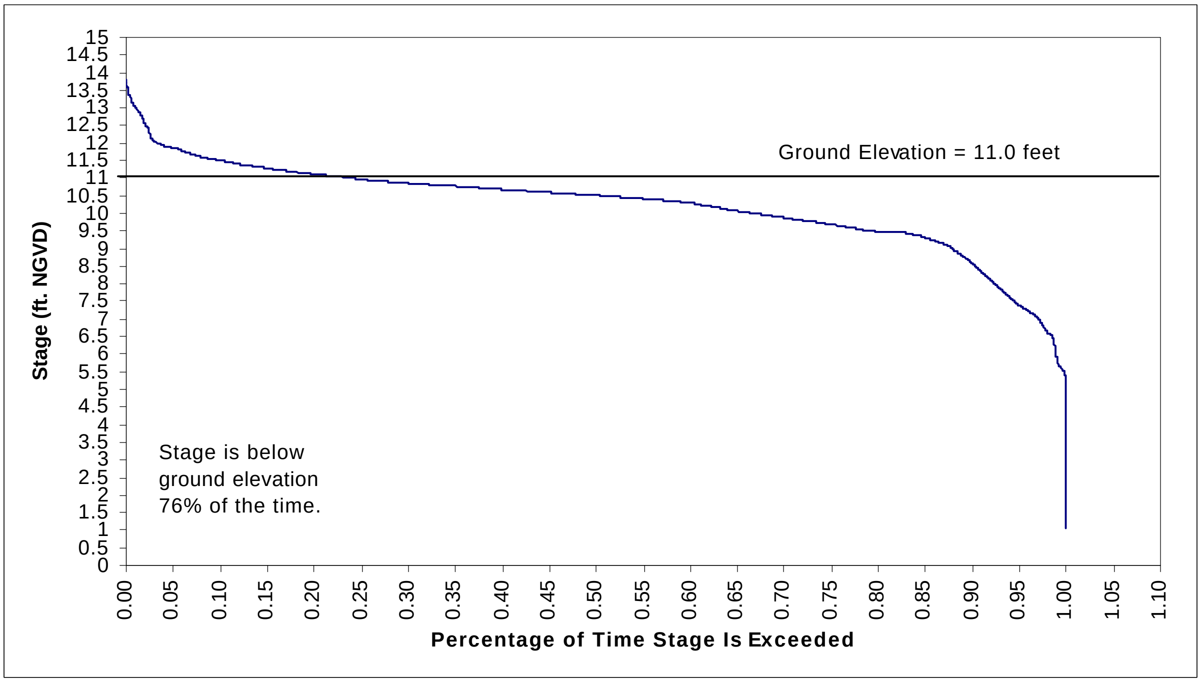


Table 6.31
WCA-3A Model Information

Description	Value
Area (acres)	31,415
Inflow boundary	Total flow across section
Outflow boundary	Constant water surface elevation across section
Approximate average ground elevation (ft)	10.7
Minimum ground elevation (ft)	0.00 (at synthetic boundary)
Maximum ground elevation (ft)	11.73
Number of nodes	2,908
Number of elements	705

Table 6.32
WCA-3A Model Parameters

Description	Maximum Design Inflow
Inflow (cfs)	1,500
Upstream water surface elevation (ft)	12.4
Downstream water surface elevation (ft)	12.27
Date of model run	September 22, 1999

Results for the WCA-3A model were presented and discussed at a progress meeting on September 23, 1999. These results indicate that the total headloss through the modeled reach was approximately 0.1 ft. The results also indicate that flow patterns in the conservation area can be significantly influenced by vegetation patterns. As shown in Figure 6.60 (presented previously), the WCA-3A model includes a combination of sawgrass and mature cattails. Model results included in Appendix F8 show the impact of vegetation distribution on flow patterns in the conservation area.

Based on the results presented at the September meeting and subsequent discussions, the project team decided that no additional runs were required to support this phase of the project.

6.4 SUMMARY

6.4.1 Observations and Recommendations

As previously discussed, Figures 6.6 through 6.58 present graphical representations of the results for the recommended design configuration. Water depth results have already been presented and discussed for each of the Cell 1A, 1B, 2A, 2B, and 3 flow scenarios, and Table 6.33 provides a summary of the model results.

Table 6.33
Summary of 2-D Model Results for Recommended Design Configuration

Model	Inflow Rate (cfs)	Area (acres)	Number of Elements	Number of Nodes	Minimum Depth (feet)	Maximum Depth (feet)	Downstream Water Surface Elevation (NGVD)	Upstream Water Surface Elevation (NGVD)	Maximum Marsh Velocity (fps)	Maximum Canal Velocity (fps)	Overall Distribution of Flow
						Maximum Design Inflow					
Cell 1A	2,170	3,408	4,605	13,760	3.59	$\boxed{5.38}$	13.80	14.40	0.073	0.670	Excellent
Cell 1B	2,170	2,941	1,608	4,959	3.06	4.38	12.80	13.30	$\boxed{0.110}$	0.730	Excellent
Cell 2A	1,980	2,867	4,683	13,962	3.53	$\boxed{5.40}$	13.80	14.41	0.079	0.910	Excellent
Cell 2B	1,980	2,410	1,513	4,650	2.14	4.46	12.90	13.50	$\boxed{0.110}$	0.840	Good
Cell 3	1,690	4,588	4,893	14,178	3.25	$\boxed{4.55}$	13.75	13.98	$\boxed{0.140}$	0.450	Excellent
						Average Annual Inflow					
Cell 1A	398	3,408	4,605	13,760	1.22	3.07	11.50	11.90	0.028	0.220	Excellent
Cell 1B	398	2,941	1,608	4,959	1.37	2.63	11.20	11.50	0.027	0.220	Excellent
Cell 2A	263	2,867	4,683	13,962	1.54	3.16	11.90	12.10	0.095	$\boxed{6.180}$	Varies
Cell 2B	487	2,410	1,513	4,650	$\boxed{0.22}$	2.61	11.20	11.90	0.053	0.450	Good
Cell 3	224	4,588	4,893	14,178	$\boxed{0.48}$	1.96	11.00	11.37	0.050	0.130	Good
Design Criteria					> 0.5	90% < 4.5			< 0.10	<2.5	

Note: Boxed numbers represent violations of design criteria

Results for Cell 1A (Figures 6.6 through 6.14) generally show an excellent distribution of flow that should fully support the treatment goals for the project. A review of unit flow results shows a slight skew of the flow in the northern part of the model to the west for the Maximum Design Inflow condition. These results also indicate a small dead zone, defined as an area of low to no flow conveyance, in the southeast corner of the model for both the Maximum Design and Average Annual Inflow conditions. A review of velocity contours and vectors indicates a similar pattern to that observed with unit flow. The noted dead zones are a result of cell geometry and are not likely to impact the overall treatment performance of the cell. Therefore, no additional improvements are recommended for the cell design.

Results from Cell 1B simulations are shown in Figures 6.15 through 6.23. These results also show an excellent distribution of flow that should fully support the treatment goals for the project. Unit flow and velocity results for Cell 1B under Maximum Design Inflow conditions are well distributed. However, there are small areas of lower flow distribution throughout the treatment area under Average Annual Inflow conditions. These areas of lower flow are produced by topographic variations in the treatment area as well as cell geometry and are not likely to impact the overall treatment performance of the cell. No additional improvements to the cell design are recommended.

Model results for Cell 2A are shown in Figures 6.24 through 6.32. As in the Cell 1A and 1B models, the results also indicate an excellent distribution of flow that should fully support the treatment goals for the project under all but the Average Annual Inflow condition. Unit flow for Cell 2A is reasonably distributed for Maximum Design Inflow conditions. As the inflow rate decreases, however, a small dead zone appears in the southeast corner of the model and flow becomes skewed to the east. This pattern is also observed in the velocity contours and vectors. Under the Average Annual Inflow condition, introduction of the discharge from Cell 3 to the Cell 2A collector canal produces significant impacts to the flow and velocity distributions within the cell. As noted in Table 6.33, the maximum velocity in the collector canal reaches 6.18 fps immediately downstream of the discharge structure, but canal velocity criteria are not otherwise violated. Design modifications, such as enlargement of the collector canal or reduction of the amount of water discharged to Cell 2A, should be considered to minimize impacts to treatment area performance.

Cell 2B results are shown in Figures 6.33 through 6.41. In general there is a good and uniform distribution of flow that should support the treatment goals for the project. However, because of the irregularity of the models' downstream boundary, this area is subject to small dead zones at the approximate midpoint of the boundary (where it sharply steps north), as well as in the southeast corner. As indicated in Figures 6.36 and 6.37 (Maximum Design Inflow), a small dead zone occurs at the boundary midpoint, but doesn't impact the cell's overall flow and velocity distribution relative to its ability to meet the design goals. This characteristic can be attributed to high spots in the cell's topography in these same areas. For lower flow rates and water depths, the impacts of these high spots are more pronounced. Review of Figures 6.40 and 6.41 shows a larger and farther-reaching unit flow and velocity dead zone at the boundary midpoint as inflow decreases. Under Average Annual Inflow conditions, this dead zone begins to impact flow distributions. To address this issue, the water surface elevation at the discharge structures could be increased for the lower flow rates. To further improve hydraulics for the south boundary, the outflow structure farthest to the east could be moved slightly closer to the cell boundary, the third outflow structure from the east could be shifted closer to the sharp northerly step, and the fourth outflow structure from the east could be shifted closer to the western corner of the second northerly step.

The interim results for Cell 3 (Figures 6.42 through 6.50), including all modifications identified from the base and alternative design modeling efforts (internal north-south levee, north-south canal along western boundary, filling the eastern portion of internal ditch 3), indicate significant problems with unit flow and velocity distributions throughout the marsh area, particularly in the southwest corner of the western sub-cell and along the north-south levee in the eastern sub-cell. Water depths differ by as much as 0.3 ft across the levee and present significant depth criteria violations under Maximum Design Inflow conditions and inflows of 1,200 cfs and greater. Significant dead zones are predicted in the southwest corner of the western sub-cell and along the north-south levee at the filled internal ditch 3 in the eastern sub-cell. These dead zones increase in size as the inflow rate decreases and cover almost half of the total treatment area under Average Annual Inflow conditions. In addition to concerns related to the dead zones, significant velocity criteria violations are observed in the marsh areas and in the collector canal under Maximum Design Inflow conditions. These excessive velocities extend across approximately one-half of each sub-cell discharge width.

In response to the generally poor flow distribution and multiple violations of design criteria, a modified collection canal/outflow structure configuration was evaluated. This modified configuration incorporates six outflow control structures along the length of the collector canal. The modified configuration also removes the north-south canal in the northwest corner of the area and the north-south levee, and restores internal ditch 3 to its original configuration with a plug one-third of the ditch length from the eastern boundary. These final Cell 3 results predict an excellent distribution of flow that should fully support the treatment goals for the project. The results from the Maximum Design Inflow and Average Annual Inflow simulations have been presented in Figures 6.51 through 6.58. Both high and low water depth criteria are violated less than 1 percent of the time, and flow and velocity distributions throughout the treatment area are uniform. A small dead zone is observed in the northwest corner of the cell, as well as along the irregular downstream boundary. The dead zone along the downstream boundary is the result of cell geometry and does not impact the overall treatment performance of the cell. The dead zone in the northwest corner of the model is also a result of cell geometry. Model results predict that this area of approximately 30 acres is underutilized for each of the flow rates studies to date. This area could be removed from the cell configuration with few hydraulic impacts. No other design improvements are recommended.

6.4.2 Sources of Error and Model Limitations

As described in the preceding sections, detailed 2-D hydraulic analyses were performed for a large number of design configurations for the STA treatment cells. These analyses were generally successful in meeting the three goals established for this subtask.

- Evaluation of the number, location, performance, and design criteria to be used for inflow and outflow control structures
- Identification of each design configuration’s 2-D hydraulic performance characteristics and evaluation of the need to construct interior berms or filling canals to improve the overall hydropattern, minimize short circuiting, and/or prevent re-suspension of particulate matter
- Generation of data which will be used to establish stage/storage relationships for treatment cell, for use in levee design and long-term simulations of the STA’s performance

Observations made from the model results identified a significant number of refinements to be included in the recommended designs. These refinements were suggested as means to improve the hydraulic characteristics in the vicinity of flow control structures, eliminate dead zones, improve the overall distribution of flow within the cells, minimize short-circuiting, and/or improve each cell's overall performance as a stormwater treatment facility. Examples of the types of refinements identified during the modeling process include:

- Relocation or addition of flow control structures
- Filling or plugging existing transverse ditches within the treatment cells
- Enlargement or other increases in the conveyance capacities of the collections canals
- Adding canals or interior berms

Despite the successes, it is important to recognize that interpretation or use of the model results should be limited relative to the known sources of error and assumptions made during the model development. Modeling of natural systems is an inexact science. All models contain sources of error which can limit their use. Key assumptions and potential sources of error inherent in the 2-D hydraulic models developed for this project include:

- Use of a single depth-variant relationship to predict shear stresses throughout the marsh areas
- Uniform boundary conditions at each of the inflow and outflow control structures
- Topographic information for the marsh areas, ditches, and canals
- Use of a constant value for the kinematic eddy viscosity to simulate losses due to mixing and turbulence

Use of a single depth-variant relationship to predict shear stresses throughout the marsh areas may be the single most significant limitation of the models. This relationship was developed from water surface profile measurements collected at the upstream and downstream boundaries of the ENR. It is representative of the mixture of vegetation (mature cattails) and open water that exists in that facility. Pending the development of similar vegetation patterns in the treatment cells for STA 3/4, this relationship will allow the models to accurately predict the overall water surface profiles within the STA 3/4 cells. Because vegetation patterns can vary significantly in space or time, however, use of a uniform relationship will not accurately simulate the internal hydraulic characteristics of the treatment cells. In fact, use of the uniform relationship is representative of ideal conditions within the cells. During actual operations, a higher degree of short-circuiting should be expected because of preferential flow channels and changing vegetative patterns. The extent, location, and density of the vegetation may change rapidly during startup and more slowly over seasonal conditions. The impacts of spatial changes in vegetation were demonstrated in the model developed for WCA-3A. If the District finds the data to be necessary in the future, the models developed for the recommended design configuration could be modified to reflect actual vegetative patterns.

During this study, inflows to the treatment cells were distributed equally to each structure at the cell's upstream boundary. Likewise, a single value was used to simulate the controlling water surface elevations at each of the outflow structures. These approximated conditions may be difficult to achieve during actual operations. The actual flow rates and water surface elevations at each structure will be influenced by the complex hydraulic characteristics of the inflow canals, discharge canals, pump stations, and headlosses specific to the structures. Because the water surface elevations on either side of a structure can vary relative to conditions in the canals and the treatment cells, the flow rates through each structure could vary significantly. Although not simulated within the FESWMS models, the design intent is to regulate the flows and water surface elevations at these structures through the use of adjustable gates. The models developed for this report represent ideal operating conditions at these gates. The magnitude of the impacts associated with these approximations will vary according to the actual operating procedures of the gates and could be simulated using in future model evaluations.

Although its influence may be less than the two sources described above, differences between topographic conditions for the constructed cells and data used in the models may also influence its results. Depressions in topography which run parallel with the direction of flow may contribute to imbalances or short-circuiting. These depressions may be remnants of the existing land uses which were not captured in field surveys performed to date or they may be unintended impacts of the construction process.

Finally, sensitivity analyses performed early in the project demonstrated that the hydraulic profiles near the flow control structures are strongly influenced by the value selected for the kinematic eddy viscosity. If detailed information on the hydraulic characteristics in the vicinity of these structures is needed, the value selected for this parameter should be verified in the field.

APPENDIX F1

2-D Model Results for STA Cell 1

APPENDIX F2

2-D Model Results for STA Cell 2

APPENDIX F3

2-D Model Results for STA Cell 3

APPENDIX F4

2-D Model Results for STA Cell 1A

APPENDIX F5

2-D Model Results for STA Cell 1B

APPENDIX F6

2-D Model Results for STA Cell 2A

APPENDIX F7

2-D Model Results for STA Cell 2B

APPENDIX F8

2-D Model Results for WCA-3A